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A SURVEY ON THE PREVALENCES OF SOIL INVERTEBRATES AROUND THE CEMENT PRODUCTING AREA OF MFAMOSING, AKAMPKA L.G.A OF CROSS RIVER STATE, CALABAR, NIGERIA

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ABSTRACT
Soil invertebrates studies was carried out in Mfamosing community, Akamkpa Local Government Area of Cross River State, South-South of Nigeria to assess the impact of the industrial activity of United Cement Company of Nigeria (UNICEM) on the prevalence of land invertebrates. A total of 1,427 invertebrate classified into 4 phylum, 6 classes, 16 orders and 21 genera were obtained. Out of which black ant (Dorylus helvolus) was the most abundant recording a total of 655(45.90%). This was followed by Nematode 144(7.98%), Springtail (Dicyrtomina sp) 79(5.53%), earthworm (L.terresris) 75(5.25%), grasshopper 65(4.55%), mite 54(3.78%), mole cricket (Gryllotalpa sp.) 44(3.08%), termite (Macrotermes nigeriense) 43(3.01%), beetle (Colosoma sp.) and millipede (Polydesmus sp.) both were 42(2.94%) respectively. Snail (Helix sp.) was 28(1.96%), spider (Sceliphron sp.) 15(1.05%), centipede 14(0.98%). Millipede (Julus sp.) and butterfly (Papillio sp.) were both 9(0.63%), praying mantis (Mantis religiosa) 8(0.56%), aphid (Aphid sp.) 4(0.28%), yellow and black wasp (Vespula sp.) 3(0.21%), dragonfly (Brachymeria furcata), moth (Hedylidae sp.), leafhopper (Eurymela distincta) and slug (Vernicelloidea sp.) all had 2(0.14%). Margalef's index calculated for Unicem was 2.88 and Aneheje with 2.9; also Shannon-Weiner index for Unicem was 0.92 and 0.87 for Aneheje. However, the closeness of these numbers was interesting and the fact that the indices are 0.05 away from each other's disprove our expectation that they would be huge impact of cement production on land invertebrate in Mfamosing.

Introduction

Industrialization is an important factor in the development of a country's economy through the establishment of industrial plant and factories. But, the waste and by-product from the industries built are severely disastrous to the environment because it consist various kind of contaminant which contaminate the soil and water [1].

Environmental pollution related to industrialization is inevitable unless proper measures are taken and the pollutant they release is directly related to the nature of the industry [17].

Consequently, one of the industries that cause significant pollution in the environment today is the cement industry. Pollutant release from the cement production industry is a major source of environmental pollution and it is therefore important to evaluate the impact of the cement production on land invertebrate community.

Soil ecosystem harbor an enormous biodiversity and it is increasingly being recognized that this diversity is essential for the maintenance of the function of the ecosystem since the activities of land invertebrates have significant effect in organization and structure dynamics of the organic matter and in growth of plant and animals.

Despite its importance, soil has become a practical and cheap alternative for final decomposition of toxic residue resulting in negative consequences. Contaminant can pose resistance to the decomposition processes carried out by soil invertebrates and therefore accumulate in the soil. Invertebrates easily become exposed to such contaminant which can affect their ecological function and influence indirectly the ecosystem and alter the ratio of predator/prey affecting the complex food chain [15].

Biodiversity conservation is important as all species are interlinked and our survival depends on the fine balance that exists within nature. The excavation of the mineral use in cement production involve considerable noise, use of powered machinery to transport the materials as well as possible processing plant to crush and mix all contribute even more disturbance to natural ecosystem and this tend to scare land invertebrates away from their habitat.

According to [13], land invertebrates are important part of the ecosystem in which they reside. They are often overlooked because of the fact that they are small.

[4] Classify invertebrate into three group base on their size and the way they interact with their habitat as thus:

Microfauna (<100μm): These are invertebrates of size less than 100μm, mostly nematode along with protozoa which are outside the scope of this work.

Merofauna (100μm -2mm): Many species of merofauna are mycophagus and therefore affect fungal population strongly. They include Acari (mites), Collembola (springtails), Enchytraeid worms, and many small larval and adult insects.

Macrofauna (2mm- 20mm): This group consists of species large enough to disrupt the soil by burrowing and feeding while the merofauna are large enough to disrupt the soil structure in their movement through soil pores. They include; coleopteran (beetle), isopteran (termites), hymenoptera (ants, wasp) etc.

In general, the micro-and merofauna appear to enhance microbial activity and to accelerate decomposition as well as mediating transport processes in the soil [4].

Importance of Land Invertebrate

Nutrient Cycle: Soil fauna community, including soil inhabiting invertebrates are known to improve soil structure by decreasing bulk density, increase soil pore space, soil horizon mixing, increase aeration and drainage, increase water holding capacity, litter decomposition and improve soil aggregate structure [2].

Majorities of soil invertebrates are saprophagous; they obtain their food from fauna and flora that are dead (they feed on dead organic matter). They serve as reservoir of nutrients that become available to plants when the invertebrates die. They stimulate fungal growth by cropping and dispersing bacterial and fungal spores, thereby enhancing mineralization.

For example, earthworm plays a major role in health of soil and plant productivity, their burrowing in soil creates channels for aeration, root penetration and water infiltration. *L. terrestis* pulls plants materials from the soil surface down into their burrows for eating at later times [9]. Their role as decomposers is critical under farmland conditions. Insect such as beetles and flies are particularly important in the breakdown of dung, carrion and leaf litter, and therefore return nutrient to the soil.

Invertebrates as determinants and indicator of soil quality: Many small organisms, such as insect and other invertebrates plays a vital role in the production and maintenance of healthy soils and therefore are key elements in the development of sustainable agriculture and forestry. Invertebrates are an integral part of soil system and that soil quality result at least in part from interactions of soil with its biotic community. Below is a summary of contribution of some of the invertebrates such as earthworms, termites, springtails, nematode etc. to soil processes.

Earthworm: According to [16], up to 50% of aggregates in European soil may be weathered earthworm cast and soils worked by earthworms have higher pore volume, increased field water holding capacity, more water stable aggregates and higher infiltration rates than soils without earthworms or only with species active on the surface. Improved soil structures result from tunneling and casting [8]. Earthworms are important in making phosphorus [18], [11], nitrogen [20], [21] and other nutrient available in the soil while enhancing microbial within the cast material. They also may make the soil suitable for springtail and other non-burrowing invertebrates by increasing the abundance of vertical pores [12].

Termites: [23]categorize the main way in which the soil is modified by termites as; physical disturbance of soil profile; change in soil texture; change in the nature and distribution of organic matter; change in the distribution of plants nutrients and hence changes in soil fertility; and construction of subterranean galleries. The construction of the huge nest and gallery system by termites involve considerable movement of soil and litter [6].

Springtails: Large species of springtails increase mineralization by selectively feeding on fungi, while smaller species help in soil humification by non-selective scavenging and by mixing organic materials and mineral soil particles [22].

Pest: Land invertebrates such as those in the taxa Chilopoda and Arachnida contain pest species that feed on germinants or underground parts of living plants. In addition to feeding on plants some groups affect man in other ways. Collembolans also infest stored products as well as water. Mite, collembolans and millipedes sometimes invade houses in such numbers as to constitute a nuisance.

Teaching Aid: Land invertebrates are excellent organisms to study genetic, physiological, ecological and evolutionary hypotheses. Some invertebrate classes show great diversity of species and numbers in closely integrated ecosystem and are readily accessible for studies.

Little work has been done on the effect of cement production of the United Cement Company of Nigeria on invertebrate community in Mfamosing. This work will help provide information on the impact of the industrial activity on the prevalence of land invertebrate in the area. The objectives were to evaluate the effect of frequently disturbed industrial activities of the united cement company of Nigeria (unicem) on invertebrate community in Mfamosing and determine the distribution of invertebrate in the industrial and non-industrial areas of Mfamosing and its environs.

MATERIALS AND METHODS

Description of study sites and field sampling

This study was carried out in two different locations in Mfamosing community, Akamkpa Local Government Area of Cross River State, South-South Nigeria, Western part of Africa. The community is the major industrial hub in Akamkpa L.G.A in which United Cement Company of Nigeria is situated. (Fig.1, Map showing the study area)

Akamkpa Local Government Area is bounded by Akpabuyo and Biase and has latitude of 4^0.510 N and 5^0.435 and longitude of 8^0.7305^{0}E and 8^0.180^{0}E. Mfamosing community has a large expanse acre of land with characteristic mountain out crop which is said to be ninety five percent (95%) dominated by limestone. The inhabitants are predominantly farmers and they engage in palm oil production, rearing of livestock, while some of its indigenes also work with the cement manufacturing company (UNICEM).

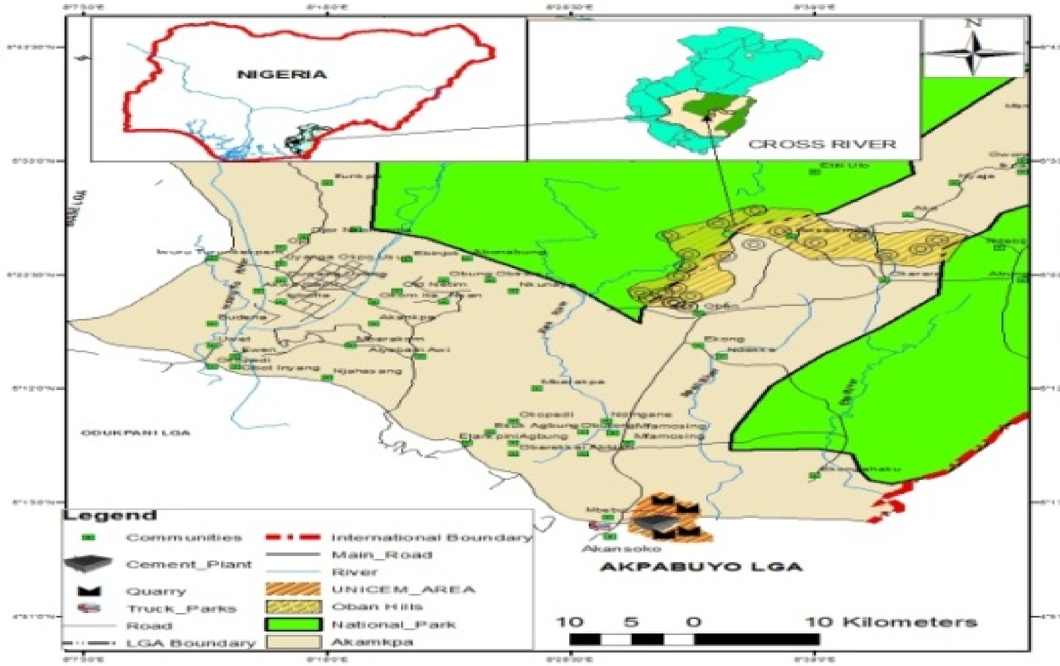

Fig.1 The study area

Sampling Station

This study was carried out in two different sampling stations.The first sampling station was located at Okon Ukpa in camp 2, where the major cement production activity takes place. The other sampling site was located at Aneheje and was used as control site. It is approximately 15minutes drive from the company (UNICEM).

Station 1: This station was located at Okon Ukpa in Mfamosing community.

It is the heart of all the production activities of the United Cement Company of Nigeria (UNICEM) and has latitude of $4^0$51' N and $5^0$43' and longitude of $8^0$73$^{'}$E and $8^0$18'E.

Station 2: According to the report of [5] it was found that soil contamination due to cement production drops sharply with increasing distance from the factory. This station is located at Aneheje and is about 15minutes drive away from the cement manufacturing company in camp 11 and has latitude of 4^0.510 N and 5^0.435 and longitude of $8^0$7305^{0}E and $8^0$180^0 E . This station was used as control site.

Sample Collection Technique

Sampling procedures are critical when assessing the distribution, abundance and species richness of invertebrates. Basic techniques have been described by [19] and good review of technique applied to land invertebrates is given by [10]. The sampling technique used was very simple and rudimentary. Growing vegetation was gently removed using cutlass, leaf debris and roots was also removed. Samples were randomly collected from within to a depth of 15cm and on soil surfaces around the study area at 25m apart. Soil litters was gently removed and placed in a polythene bag.

Cutlass was used to dig the soil and collect samples at the depth of 15cm. At each study site a total of 30 samples were collected for six times. A grand total of 360 samples were collected and each sample site labeled accordingly and transferred to Zoology and Environmental Biology laboratory for analysis. In the laboratory, soil samples were individually emptied into a tray and larger invertebrate fauna was sorted out using a pair of forceps and a magnifying glass. Soil was put in petri dish and observed under light microscope. Soil invertebrate seen was picked using forceps into specimen bottles containing 70% ethanol to ensure preservation. For smaller invertebrates, soil was passed through Berlese extraction funnel; heat was applied to lamp holder and held by a metal cylinder. The heat source was placed a few inches above the soil. To obtain maximum result 60wt bulb generating temperature at about 30-40°c was used to heat for 2 - 3 hours. Invertebrates present were driven down through the sieve and funnel into a collecting beaker. Invertebrates were identified using land invertebrate picture books, use of keys available in standard textbooks and other related literatures.

RESULTS AND DISCUSSION

A total of 1427 invertebrate were obtained, out of which black ant (*Dorylus helvolus*) was the most abundant recording a total of 655(45.90%). This was followed by Nematode 144(7.98%), Springtail (*Dicyrtomina sp*) 79(5.53%), earthworm (*L.terresris*)

75(5.25%), grasshopper 65(4.55%), mite 54(3.78%), mole cricket (*Gryllotalpa sp.*) 44(3.08%), termite (*Macrotermes nigeriense*) 43(3.01%), beetle (*Colosoma sp.*) and millipede (*Polydesmus sp.*) both were 42(2.94%) respectively. Snail (*Helix sp.*) was 28(1.96%), spider (*Sceliphron sp.*) 15(1.05%), centipede 14(0.98%). Millipede (*Julus sp.*) and butterfly (*Papillio sp.*) were both 9(0.63%), praying mantis (*Mantis religiosa*) 8(0.56%), aphid (*Aphid sp.*) 4(0.28%), yellow and black wasp (*Vespula sp.*) 3(0.21%), dragonfly (*Brachymeria furcata*), moth (*Hedylidae sp.*), leafhopper (*Eurymela distincta*) and slug (*Vernicelloidea sp.*) all had 2(0.14%) each and insect larvae was 116(8.12%). Therefore, black ant and earthworm recorded higher percentage abundance than all other invertebrate sample during the study.

Out of the 4 phylum obtained, phylum arthropoda 1,208(85%) was the highest recorded out of which 796(65.89%) was recorded in Aneheje and 412(34.10%) in Unicem. This was followed by phylum nematoda 114(8%) with 74(65%) in Aneheje and 40(35%) in Unicem, phylum annelida with 75 (5%) with 58 (77%) in Unicem and 17(23%) in Aneheje, the phylum mollusca with 30 (2%) with 4 (13.3%) recorded in Unicem and 26(86.6%) recorded in Aneheje. (Fig.1) This result indicates that they was a significant difference (P<0.05) in the distribution of various identified land invertebrates among themselves and among the study locations.

In terms of invertebrates classes, the class insecta recorded highest with 1,074 (75%), arachnida 69(5%), secernentea 114(8%) myriapoda 65(5%), clitellata 75 (5%), and gastropoda 30(2%).

More so, the result showed variation in the class abundance in different sampling stations. Out of the 1,074 (75%) recorded by the class insecta, Unicem was 379(35%), while Aneheje recorded 695(65%), the class arachnida 69(5%) with Unicem 21(30%), Aneheje 48(70%), the class secernentea 114(8%) with Unicem 40(35%), Aneheje 74(65%), the class myriapoda 65(5%) with Unicem 12(18%), Aneheje 53(82%), the class clitellata 75(5%) with Unicem 58(77%), Aneheje (23%), and the class gastropoda 30(2%) with Unicem(13%) and Aneheje (87%). Taxa richness calculation as Margalef"s index (d) was least in Unicem (2.88) and high in Aneheje (2.93) with 0.05 away from each other. Furthermore, Shannon-Weiner diversity index that was calculated for each site showed Unicem to be 0.92 and Aneheje was 0.81 also with 0.05 differences away from each other. Equitability was least in Aneheje (0.28) and highest in Unicem (0.31). The two stations had more or less equal diversity with insignificant different indices value. The phylum arthropoda is by far the largest phylum in animal kingdom.

Percentage composition and relative abundance of invertebrate fauna in the various sampling sites in Mfamosing, Akamkpa L.G.A, Cross River State

TAXA	UNICEM	%	ANEHEJE	%	TOTAL	%
Arthropoda						
Collembola						
Dicyrtomina sp.	30	5.83	49	5.36	79	5.53
Isoptera						
Macrotermes nigeriense	19	3.69	24	2.62	43	3.01
Orthoptera						
Gryllotalpa sp.	16	3.11	28	3.06	44	3.08
Locusta migratoria	47	9.14	18	1.97	65	4.55
Hymenoptera						
Dorylus helvolus	209	40.66	446	48.84	655	45.90
Vespula sp.	-	-	3	0.32	3	0.21
Coleoptera						
Colosoma sp.	11	2.14	31	3.39	42	2.94
Odonata						
Brachymeria furcata	2	0.38	-	-	2	0.14
Dictyoptera						
Mantis religiosa	2	0.38	6	0.65	8	0.56
Lepidoptera						
Papillio sp.	7	1.36	2	0.21	9	0.63
Hedylidae sp.	0	-	2	0.21	2	0.14
Homoptera						
Eurymela distincta	2	0.38	-	-	2	0.14

Aphid sp.	1	0.19	3	0.32	4	0.28
Insect larvae	33	6.42	83	9.09	116	8.12
Myriapoda						
Chilopoda						
Scolopendra sp.	4	0.77	10	1.09	14	0.98
Diplopoda						
Polydesmus sp.	8	1.55	34	3.72	42	2.94
Julus sp.	-	-	9	0.98	9	0.63
Arachnida						
Arenida						
Sceliphron sp.	4	0.77	11	1.20	15	1.05
Acarina						
Oribatidae sp.	17	3.3	37	4.05	54	3.78
Mollusca						
Gastropoda						
Pulmonata						
Helix sp.	4	0.77	24	2.62	28	1.96
Veronicelloidea sp.	-	-	2	0.21	2	0.14
Anellida						
Clitellata						
Oligochaeta						
L. terrestis	58	11.28	17	1.86	75	5.25
Nematoda						
Secernentea sp.	40	7.78	74	8.10	114	7.98
Total	**514**	**100**	**913**	**100**	**1427**	**100**

Source: Field survey, 2022

[14] Reports that approx. 713,500 species or about 80% of all the species in the animal kingdom are arthropod. Looking at the figures and tables put together, there was differences in the abundance of invertebrates fauna obtain from the two sampling stations. Margalef's index which is the measure of species richness calculated for Unicem was 2.88 and Aneheje was 2.9. Shannon-Weiner index showed that Unicem was 0.92 and 0.87 in Aneheje. However, what was interesting here is how close these numbers are. The fact that the indices are 0.05 away from each other disproved my expectation that they would not be diverse invertebrate species at the industrial area of Mfamosing (Okon Ukpa) when compared to industrial free area of Aneheje considering the high level of environmentally unfriendly threat posed by the cement production factory on soil and litter-dwelling invertebrates. This findings is supported by the report of [13]in their work, the authors compared invertebrate fauna collected from industrialized location of Pioneer Park, Kenton County, Kentucky that of Withrow Nature preserve, Cincinnati, Ohio a non-industrial location. Their overall result showed that each site was pretty similar when it came to species richness and diversity of organisms within the sample locations.
Furthermore[7]reported that geophagus organisms (those that taking in large amount of soil during feeding on well decomposed organic material) and those living on or near the soil surface may have greater exposure to chemical than worm feeding on litter pulled down into burrows in the sub-soil. This supports our findings which showed high abundance of earthworm (*L. terrestis*) in Unicem and a competitive number of nematode.
[3] asserted that nature has provided biodiversity with certain form of habitat and not as adaptable as man to the surrounding. Thus, the expansion of human population and unfolding of human's horizon to exploit resources for economic and other purposes tend to displace such indigenous resources and can even put some species into extinction, if not addressed with caution. The capacity of invertebrate to be adaptive to changing environment varies within species. This study revealed the absence of Millipede (*Julus sp.*), leafhoppers (*Hedylidae sp.*), and Centipede (*Scolopendra sp.*) was also reported to be relatively low. This absence can be attributed to the fact that this organism (*Julus Sp.*) tend to fold or "play death" when they are disturbed or encounter obstacle. This may compel them to migrate. Furthermore, hymenoptera, collembolans were found in both sampling stations at high abundance, collembolans are considered biological regulators and have important functions in ecosystems. They are known to feed on bacteria, fungi, mineral soil particles, organic matter, protozoa and nematodes and increase soil respiration and accelerate nitrogen mineralization.
The activities of cement production in unicem factory has been going on for years now and so one would expect invertebrate to have developed enhanced resistance to this threat and adapted to it. Soil invertebrate like the mole cricket may remain dormant or inactive when natural environment is disturbed.

Conclusion

Frequent disturbance of natural invertebrate habitat by pollutants such as dust, noise, vibrations, gaseous emission, and air-borne particles from the cement production factory (Unicem) will produce low population of invertebrate fauna. This no doubt will affect the physiological activities of soil and litter-dwelling invertebrates most especially those at the quarry site. The implication of these is that some of the invertebrate may have retarded growth while others may be compelled to migrate. This work will serve as a tool of information for researchers and pave the way for other works that will precede this one.

As indicated by the indices, both locations are very diverse this is a positive aspect that came out of this work. More intensive studies are therefore recommended to investigate other parameters this research work could not cover such as seasonal variations in the distribution of land invertebrate, determining the abundance and distribution of soil invertebrate present at each study location in terms of the different soil layers and evaluating the characteristics that enhance the survival of invertebrate in an industrialized location such as Okon Ukpa (Unicem), Mfamosing.

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